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Spline-Based Methods For Fluid-Structure Interaction

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The introduction of isogeometric analysis (IGA) [1], made it possible to directly exploit the favorable geometric properties of NURBS for numerical analysis. The method has become wide-spread in structural mechanics. However, parametrizing complex three-dimenional domains — as needed for CFD — using closed volume splines can be challenging. NURBS-enhanced finite elements (NEFEM) [2] can be a viable alternative. Both methods together lead to a geometrically compatible coupling interface for FSI. Thus, the geometric gap between the discretizations is closed. Within a partitioned FSI method, it was demonstrated that the neccessary projection methods simplify due to the matching geometry; while at the same time increasing accuracy [3].

In the current work, we apply the described approach to FSI problems involving incompressible flows. In these problems, accurate geometric representation can be important, e.g., in case of enclosed domains or free-surface flows. Advantages of the proposed methods are demonstrated using several test cases. For this purpose a partitioned approach is applied. The incompressible Navier-Stokes equations are solved by the Deforming Spatial Domain/Stabilized Space-Time (DSD/SST) procedure extended by NEFEM. The elastodynamics problem is solved by means of NURBS-based isogeometric analysis. Results are compared against solutions obtained with a standard finite element formulation.

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